Claims

We claim:

1. A method for decoding a received word for a finite geometry code, comprising:
    a one-time initialization procedure; comprising:
        defining a parity check matrix for the finite geometry code;
        representing each bit in the received word by an element, each element having either a zero, one or uncertain value; and
    an iterative decoding procedure, comprising:
        terminating when a termination condition is true, and otherwise:
        determining a set of votes for each element depending on the parity check matrix and current values of the elements;
        updating the elements based on the set of votes for each element and the received word.

2. The method of claim 1, in which the parity check matrix representing an (N,k) finite geometry code has M rows and N columns and rank N-k, and the M rows are incidence vectors of a set of selected μ-flats in the finite geometry with respect to N points of the finite geometry, each row containing J ones and N-J zeros.

3. The method of claim 1, in which the μ-flats are cyclic shifts of each other.

4. The method of claim 1, in which each of the elements express a state of the decoder corresponding to a bit of the received word, and the termination condition is satisfied when the state of the decoder is a code-word.

5. The method of claim 1, in which the initialization procedure and the decoding procedure are restarted with a substantially larger parity check matrix if the termination condition is satisfied and the state of the decoder does not correspond to a code-word.

6. The method of claim 1, in which each row of the parity check matrix corresponds to a parity check, and each parity check sends votes to J elements, where the elements that a parity check sends a vote to correspond to the columns of the parity check matrix that have the value 1 in a row corresponding to the parity check.

7. The method of claim 6, in which the vote for a particular parity check to a particular element is determined by states of the J-1 other elements associated with the parity check.

8. The method of claim 6, in which the vote from a particular parity check to a particular element is an abstention if any of the J-1 other elements associated with the parity check has the uncertain value, and is one when the number of other elements associated with the parity check having a value of one is odd, and is zero otherwise.

9. The method of claim 6, further comprising:

determining a recommendation and strength of recommendation for each element from the associated parity checks that send a vote to it.

10. The method of claim 9, in which the recommendation is zero when a majority of the votes are zero, the recommendation is one when the majority of the votes are one, and there is no recommendation when the zero and one votes are equal.

11. The method of claim 10, in which the strength of the recommendation is a magnitude of a difference between the number of zero votes and the number of one votes.

12. The method of claim 11, in which the votes determine a next updated state of a particular element by means of a comparison of the strength of the recommendation of the parity checks with a threshold b_{flip} and a threshold $b_{uncertain}$.

13. The method of claim 12, in which the next updated state of a particular element is equal to a value in the received word if the recommendation of the parity checks agrees with the value in the received word.

14. The method of claim 12, in which the next updated state of a particular element is equal to a value in the received word if the recommendation of the parity checks is not equal to the value in the received word, and the strength of the recommendation is less than the threshold $b_{uncertain}$, and the next updated state of the particular element is a state representing uncertainty if the recommendation of the parity checks is not equal to the value in the received word, and the strength of the recommendation is greater than or equal to the threshold $b_{uncertain}$, and less than the threshold b_{flip}, and the next updated state of the particular element agree with the recommendation of the parity checks if the strength of the recommendation is greater than the threshold b_{flip}.

15. The method of claim 12 further comprising:

updating the values of the thresholds at an end of each decoding cycle, according to a pre-determined schedule.